REMARKS

I. INTRODUCTORY REMARKS

Reconsideration and allowance are respectfully requested.

The Applicants thank the Examiner for his examination to date.

In the January 19, 2007 final office action, the Examiner rejected claims 1-3, 6-13, 16-47, 49-50, 66-73, and 98-101. The Applicants believe that all amendments submitted herein are within the purview of Rule 116. For example, the present amendments merely simplify issues for appeal and do not require new searching. The Examiner is requested to contact the undersigned if he believes differently.

Only one issue now remains after the present amendments: obviousness.

After this Amendment, the only present independent claims are claims 1, 40, and 47, as explained below.

Before this Amendment, there were four independent claims: 1, 40, 47, and 66. The Applicants presently amend independent claims 1, 40, and 47 to recite sol-gel material, a term taken from dependent claims 24, 43, 50, and 73. Therefore, this amendment does not introduce new matter as sol-gel was described throughout the filed specification and in the filed claims 24, 43, 50, and 73. Dependent claims 24, 43, 50, and 73 are cancelled.

Former independent claim 66 has been amended to now be a dependent claim.

Claim 101 is amended for clarity.

The Applicants also cancel withdrawn claims 4-5, 74-78, and 83-97.

The Applicants clarify that claim 14 is cancelled. Claims 16, 26-28, 42, and 49 are also cancelled.

The Examiner rejected claim 6 as being indefinite. While the Applicants traverse this rejection, the Applicants cancel claim 6 herein to simplify issues for appeal.

The Applicants herein address the drawings and specification issues raised by the Examiner. The applicants submit again Figures 19 and 21 with the hope that the PTO scanning process does not interfere with their clarity. The Examiner should contact the undersigned if any

more problems are deemed present. The applicants believe that this issue should not prevent allowance.

II. RESPONSE TO PRIOR ART REJECTIONS

The Applicants have taken major steps to substantially simplify the issues. The Examiner cited at least seven references in at least seven separate rejections. The applicants respectfully traverse each of these rejections. However, the applicants believe that in view of the present amendments, the prior art issues reduce for purposes of appeal to those rejections and references relevant to now cancelled dependent claims 24, 43, 50, and 73, which had recited sol-gel material. The three references used against these claims in the office action were: (i) Lewis et al. article, October 25, 1999, 2689, *Applied Physics Letters* ("Lewis"), (ii) US Patent No. 5,871,869 ("Park"), and (iii) US Patent No. 6,270,946 ("Miller"). The other references were not cited against these claims and are deemed therefore to no longer be an issue.

Therefore, prosecution has now reduced to one issue: whether the subject matter of the presently pending claims, including independent claims 1, 40, and 47 would have been obvious over the combined teachings of Lewis, Park, and/or Miller. The Applicants respectfully assert that anticipation is no longer an issue.

For reasons explained below, the claimed subject matter would not have been obvious because even if the references are combined for sake of argument, the claimed invention is not arrived at. A missing element is present, so no prima facie obviousness can be present. Moreover, no motivation is present to combine the references, even if it is asserted that there is no missing element for sake of argument.

The References Fail to Teach at Least One Claim Element

Claim 1 recites that the method uses deposited materials for additive repair of a defective mask. In other words, the deposited material is formulated for additive repair of a defective mask in need of an additive repair. None of the references recite additive repair of a defective mask, the defective mask itself in need of additive repair, and the materials needed for same.

Lewis only describes and enables subtractive repair. Lewis teaches etching away and removing chrome material with use of a liquid etchant (the liquid etchant is of course removed and not a permanent addition to the surface). Lewis does not teach or suggest adding material adapted for additive repair. Lewis' teachings about chemistry simply are not specific enough to reach additive repair.

Miller and Park also fails to teach additive repair of a defective mask. The references make no mention of providing a mask in need of additive repair and materials able to repair the mask in a functionally useful way.

Hence, a missing element is present. Even if all of these references are combined for sake of argument, the claimed invention is not arrived at. None of the references provide the defective mask in need of additive repair.

In the office action (pages 8-9), the Examiner appear to rely on inherency in showing that Lewis can teach additive repair. The applicants respectively disagree that inherency can be used in this context. First, inherency requires that the inherent feature <u>necessarily</u> be present in the prior art. Here, in stark contrast, Lewis repeatedly focuses on subtractive repair, the exact opposite of additive repair. Lewis does not expressly or inherently provide a defective mask in need of additive repair. Additive repair is not necessarily present in any Lewis teaching. Lewis provides no specific guidance, suggestion, or enablement on how its methods can be used for additive repair. Indeed, the Examiner correctly states in the Office Action, page 10 that "Lewis et al. do not teach specific examples or any detailed description of such additive repair for patterned masks." In this context, inherency is not relevant. Second, inherency is most frequently and soundly used in an anticipation rejection, not an obviousness rejection. Indeed, the Examiner resorted to inherency while maintaining a 102(b) anticipation rejection. Now, however, the only issue is obviousness. Again, inherency is not relevant now in this context.

In the office action, the Examiner also at pages 9-12 appears to say that the combination of Lewis and Miller somehow teach additive repair of a defective mask. The combination of Lewis and Miller, however, do not teach additive repair. The deficiencies of Lewis are stated above. Lewis does not teach the defective mask in need of additive repair. Similarly, Miller

simply fails to teach additive repair of a defective mask. When the Examiner states on page 10 that "Lewis et al. do not teach specific examples or any detailed description of such additive repair for patterned masks.", the Examiner should also say this about Miller. Miller does not teach specific examples or any detailed description of additive repair of patterned masks having defects. Miller, moreover, provides no working examples. Miller is a paper patent devoid of specific teachings. Miller provides no specific description or examples of any ink formulations for mask repair beyond the general, vague notion of a difunctional monomer, oligomer, or polymer molecules comprising functional groups (col. 2, lines 39-67). Miller does not teach or suggest an appropriate carrier system or solvent system for its difunctional molecules. Miller's molecules would simply clog nanoscopic openings without an adequate carrier system or solvent system. Indeed, Miller is trying to avoid anything to do with masks so as to "provide a method to directly fabricate nanoscale electronic devices without using a mask." (col. 1, lines 42-48).

This record, therefore, presents a missing element: no additive repair is taught, wherein a defective mask receives material which adds to the mask and fixes a repair.

Finally, independent claims 40 and 47 also recites use of patterning compound for additive repair. The arguments noted above for claim 1 also apply to claims 40 and 47.

Other missing elements can be also present.

<u>No Motivation is Present to Combine References</u>

In addition, no motivation is present to combine any of the three references, or subcombinations thereof, even if it is assumed that there is no missing element for sake of argument. Any combination of these three references reflects impermissible hindsight. No motivation is present to combine Lewis and Park, or the combination of Lewis, Miller, and Park.

First, the inventors faced a problem associated with additive repair of masks. None of the references teach or suggest additive repair of masks. Hence, one would not turn to any of these references, let alone combine them. Materials useful for subtractive repair are not useful for additive repair, and vice-versa. For example, one reference provided herewith teaches that additive repair is more difficult:

> The repair of opaque defects (i.e., removal of chromium spots from areas in which they do not belong) has been performed with lasers for many years (i.e. *laser zappers*). The repair of *clear defects* (i.e. the deposition of chromium in areas from which it should be missing) has proven more difficult. *Silicon Processing for the VLSI Era*, page 486.

In contrast, the primary reference, Lewis, teaches subtractive repair, directly opposite to additive repair. Lewis teaches away. If for sake of argument one assumes Miller says anything about additive repair, one would not combine a subtractive repair reference (Lewis) with a hypothetically additive repair reference (Miller). Moreover, Lewis teaches depositions of etching liquids which are a combination of cyanide, hydroxide, and water (page 2690, bottom left). Miller does not teach deposition of etching liquids but only vaguely teaches somehow depositing monomer, oligomer, or polymer which is functionalized and which does not need solvent – very different from an etching liquid with a different purpose. Lewis says nothing about use of functionalized materials. In contrast, Miller requires functionalized materials. Incorporating the teachings of Lewis into Miller destroys Miller, and incorporating the teachings of Miller into Lewis would destroy Lewis. Therefore, motivation to combine these references is not present.

Furthermore, Park teaches nothing about repair of masks, let alone additive repair, or use of nanoscale tip methods such as scanning probe or AFM methods for same. Hence, one would not combine Park with Lewis. Park merely teaches how to fabricate a mask using unspecified methods to deposit sol gel layer without use of tip patterning. Lewis requires use of a tip for patterning. Park requires a relatively thick film (1,400-3,100 angstroms) in the first steps of the process in contrast to Lewis which does not recite any need for film thickness as Lewis is subtractive repair only. One would not use a tip in Lewis to carry out Park, trying to form a thick patterned film, as this would not be practical at first blush in a fast fabrication process. One would not use the generic deposition methods of Park to execute Lewis subtractive repair.

Moreover, the sol-gel materials as presently claimed and as taught in Park would be expected to clog and prevent fluid flow in the very small diameter nanopipette openings as taught in Lewis. Sol-gel materials are designed to react to form particles and solids, so one would not

want to use a Lewis device with nanoscale opening. Therefore, one would not be motivated to combine Park with Lewis or vice-versa.

Similarly, one would not combine Miller with Park for reasons analogous to not combining Park with Lewis. Moreover, Miller is directly teaching away from mask based processes, and Park teaches mask processes. The tip-based method of Miller works against Park, which needs a fast even film as part of a microfabrication process.

In sum, no motivation is present to combine references.

Concluding Remarks

In a nutshell, the Applicants have found an inventive sol-gel approach to additive mask repair which is not taught or suggested by these references, individually or in combination. Sol gel materials and additive repair are not compatible with Lewis. The Lewis devices would clog.

The Examiner is also invited to examine the merits of the dependent claims separately.

Finally, the Applicants believe that the remaining references in the office action (Cohen, Bard, and Yedur) do not teach or suggest sol-gel approaches to additive repair.

For the record on appeal, the Applicants incorporate by reference their prior remarks about patentability into this Amendment.

If the Examiner has any questions or comments about the present Amendment, he is invited to contact the undersigned to efficiently resolve any issues.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 CFR §§ 1.16-1.17, or any other provision, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741.

Respectfully submitted,

Date June 4, 2007

By [signature]

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SILICON PROCESSING FOR THE VLSI ERA

VOLUME 1:

PROCESS TECHNOLOGY

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were carried out by a human operator working with a microscope. As masks have become more complex, this task has been relegated to automatic defect detection systems that perform the task much more rapidly, and with fewer errors[39,40]. These systems are also able to plot the distribution and size of defects over an entire mask. Defects (e.g. pinholes) as small as 0.35 μm are detectable with ~95% probability on optically transparent substrates with the most recently designed systems. Since the detection of small defects by automatic systems is a probabilistic process, mask makers commonly run a reticle through an automatic system several times, to guarantee that all defects have been located.

Several automatic mask /reticle defect detection systems are being sold, including the KLA KLARIS[39], and the Cambridge Instrument's Chipcheck[41]. The most advanced models have the capability of performing both die-to-die and die-to-database inspection (Fig. 27). The *die-to-die* inspection allows defects unique to an individual die to be identified. *Die-to-database* inspection allows repeating defects to be found (which would not be detected by a die-to-die comparison), as well as errors made in converting data from the computer memory format to the mask /reticle pattern. With systems that can perform both such inspections, only one die of a mask array must be inspected against the database, while die-to-die inspection checks each die for random defects. A defect detection system based on holographic principles is also available[40]. It is specified to detect particles ≥ 0.5μm, and to be able to inspect masks with pellicles attached.

As a final check before going from reticle or mask to wafer, a glass wafer can be used[42]. With only a few die exposures on a glass wafer, an automatic reticle inspection system can qualify a reticle within minutes. Such glass wafers are dimensional replicas of standard silicon wafers offered in 76, 100, 125, and 150 mm sizes, and coated with a thin film of aluminum.

Repairing Defects in Masks and Reticles

Since fatal defects in a mask or reticle are obviously highly undesirable, or in cases of one die per reticle, entirely unacceptable, it would be useful if such defects could be repaired, thereby rendering the mask free of fatal defects. Mask repair methods for accomplishing this purpose

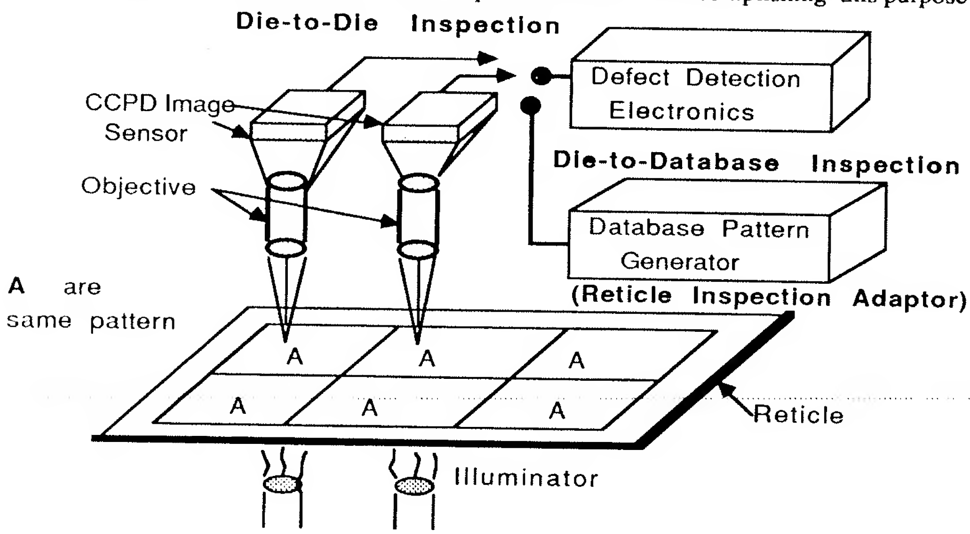

Fig. 27 Automatic defect detection instrument for masks and reticles. Courtesy of KLA Instruments Corp.

have been developed. The repair of *opaque defects* (i.e. removal of chromium spots from areas in which they do not belong) has been performed with lasers for many years (i.e. *laser zappers*). A focused laser beam merely evaporates unwanted material. One concern with laser evaporation is potential damage of the glass substrate. Large chrome spots may require several laser pulses to remove them, and if damage (*laser burn*) occurs, it can become another printable defect.

The repair of *clear defects* (i.e. the deposition of chromium in areas from which it should be missing) has proven more difficult. The most widely used process is a chromium lift-off procedure, which requires hours of processing time, and may introduce additional defects (Fig. 28a). As a result, several alternative methods have been developed. One uses a local pyrolytic decomposition of a chromium bearing-gas at the spot where the clear defect exists. The gas is delivered by a process-gas delivery needle into the space between a 100X microscope objective and the reticle surface. An argon laser beam is delivered through the microscope optics, and this beam increases the temperature of the desired spot (~1 μm in size) on the substrate surface to 150°C. This causes decomposition of the gas, and consequent local deposition of the chromium at the heated spot. Such deposited patches can be controlled in the 1-2 μm size range, and since they are composed of chrome, can be trimmed by a YAG laser to submicron dimensions for *mouse-nip* filling (Fig. 28b). Another method involves the application of epoxies (dispensed by pipette, while observing with a high-magnification, wide-field microscope). A third technique utilizes a focused ion beam to deposit chrome onto local regions of the substrate, or to locally etch a fine diffraction grating pattern onto the glass surface, so that it appears effectively opaque.

Pellicles

Even though masks and reticles used in projection printing can be fabricated without defects (i.e. by utilizing repair techniques if necessary), and no damage-creating contact between mask and wafer occurs, mask defects due to handling or airborne contamination can still be generated. In the regime of ≤ 1 μm resolution, particulates that are large enough to cause defects are also harder to detect and remove. Thus, even in projection printing processes, a method for

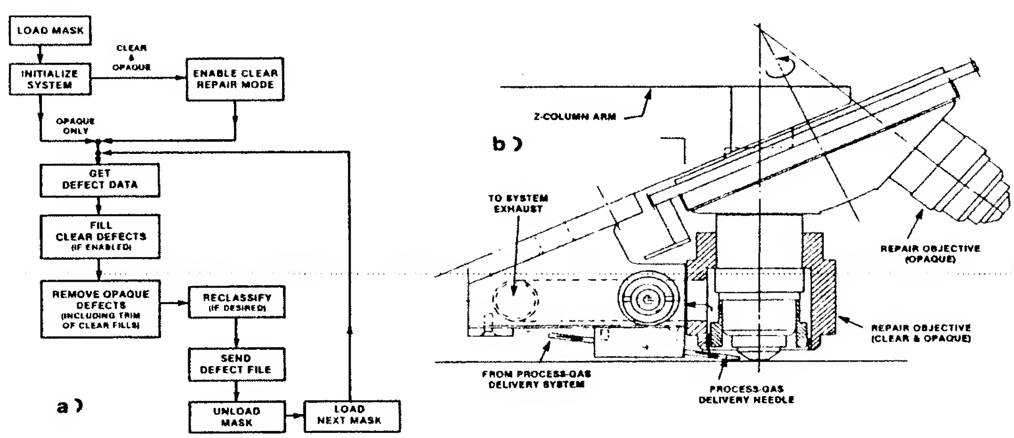

Fig. 28 (a) Typical photomask lift-off repair process cycle. (b) Opaque mask defect repair process by pyrolytic decomposition of chromium-bearing gas. Courtesy of Quantronix Corp.